

SYMPOSIUM ON STEPPING STONES TO THE FUTURE: STRATEGIES, ARCHITECTURES,
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Infrastructures and Systems to Enable Ambitious Future Exploration and Utilization of Space (3)

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SILKY WAY: SCALABLE AND RESILIENT INTERPLANETARY COMMUNICATION
INFRASTRUCTURE BASED ON PERCOLATION THEORY

Abstract

The second half of the 21st century will witness the realization of mankind's long-standing dream of interplanetary travel within the boundaries of the solar system. This will be undertaken not only for exploratory and research purposes, but also commercial reasons driven by the private sector space industry. In such circumstances, reliable long distance communication throughout the solar system will become a critical requirement. To develop and maintain a cosmos-age communication infrastructure is a major challenge, as it must satisfy a number of key requirements, namely resilience, scalability and cost efficiency. This paper proposes Silky Way, a model for a solar system wide space communications infrastructure that is developed to meet the above requirements. Silky Way uses a graph-theoretic approach to the design of a satellite constellation that introduces a critical threshold, which is then used to determine the minimum number of operational satellites necessary to achieve reliable communication coverage throughout the system. The approach in this model is inspired by Percolation Theory and its application in Physics.